TECHNICAL REVIEW OF A THRESHOLD-BASED APPROACH FOR DETERMINING SIGNIFICANT DEGRADATION IN ALASKA

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OVERVIEW

The primary goal of this white paper is to deliver an objective evaluation of a threshold approach for assessing the severity of aquatic resource impacts (i.e., potential for significant degradation) from development projects in the state of Alaska permitted under Section 404 of the Clean Water Act. Accordingly, the information presented in this white paper covers: 1) a brief introduction into the environmental statutes and regulatory requirements which underpin the necessity of such an assessment, 2) a description of the proposed threshold approach, along with a synthesis of the scientific literature upon which this approach is based, followed by 3) a discussion examining the limitations of the scientific literature and evaluating whether the scientific literature has been applied appropriately, and, ultimately 4) a final conclusion determining the suitability of the threshold approach for the purpose of such an assessment. Review of the scientific literature, reveals that the proposed threshold approach is based on misinterpretations and misapplications of the literature. These findings lead not only to the conclusion that the approach is technically flawed and not supported by the science, but also to the determination that the implementation of such an approach is not suitable for evaluating significant degradation. The findings and conclusions presented here have been reviewed, and validated, by three experts whose research was cited in the development of the proposed threshold approach.[1]

INTRODUCTION

Section 404 of The Clean Water Act

Clean Water Act Section 404 permits, which authorize the discharge of dredged or fill material into waters of the United States, must comply with the Section 404(b)(1) Guidelines (the Guidelines).[2] Among their requirements, the Guidelines prohibit the discharge of dredged or fill

[1] A draft version of this white paper was reviewed by three individual authors whose research was cited in the development of the proposed threshold approach: Dr. Thomas Schueler (Executive Director, Chesapeake Stormwater Network), Dr. Derek Booth (Adjunct Faculty, Bren School of Environmental Science & Management, University of California, Santa Barbara) and Dr. Ryan Utz (Assistant Professor of Water Resources, Chatham University). The initial request for reviews occurred between the dates of April 18th and April 20th, 2018; and final reviews were received between the dates of April 30th and May 14th, 2018. The reviews we received from these authors validated our interpretation of the scientific literature, supported our concerns regarding the application of the scientific literature, and endorsed the overall conclusions reached from this evaluation.

[2] 40 CFR § 230.

ED_005447I_00034781-00001 Bristol Bay/Pebble Mine Permitting Process FOIAs_Final Release

material that will *cause or contribute* to significant degradation of the Nation's waters.[3] Determinations regarding significant degradation are based on an analysis of the direct, secondary, and cumulative impacts of the proposed discharges on the aquatic system. Such determinations require consideration of the effects on the physical, chemical, and biological components of aquatic ecosystems including, the magnitude or size of the impact, the quality of the resource (e.g., the existing functions, the potential severity of functional impairment, the uniqueness and/or rarity of those functions), and the persistence or permanence of the impact. Furthermore, determinations of significant degradation must consider effects of the discharge on: 1) human health and welfare, 2) life stages of aquatic life and other wildlife dependent on aquatic ecosystems, 3) aquatic ecosystem diversity, productivity, and stability, and 4) recreational, aesthetic, and economic values.

Although the regulations do not identify the degree of impact that constitutes 'significant degradation', nothing in the regulatory language suggests that the threshold of significance is high. The preamble to the Guidelines states that significance is "more than trivial" and should be considered in the conceptual rather than the statistical sense.[4] The regulations also do not require any specific quantitative analysis to make determinations regarding significant degradation and do not include any formulas or defined thresholds for determining significance (e.g., all fills >10 acres are significant). Therefore, determinations regarding significant degradation are to be made on a case-by-case basis using factual site-specific information, and the level of analysis and documentation should correspond to the scope and scale of the impacts.

If concerns regarding significant degradation persist after all appropriate and practicable steps have been taken to first avoid and minimize the adverse impacts of a proposed discharge on the aquatic ecosystem, compliance with the Guidelines may require inclusion of compensatory mitigation measures in order to bring impacts down below the level of significance. Similarly, compensatory mitigation may be required to ensure that discharges do not cause or contribute to a violation of water quality standards or jeopardize a threatened or endangered species or result in the destruction or adverse modification of critical habitat under the Endangered Species Act.[5] The Guidelines also require inclusion of compensatory mitigation measures when such measures are appropriate and practicable.[6]

BACKGROUND

Recent Threshold Approach to Evaluating Significant Degradation in Alaska

Project proponents within the U.S. Army Corps of Engineers Alaska District have recently employed a new threshold-based approach to determining when impacts may cause or contribute

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[3] 40 CFR § 230.10(c).
[4] 45 Fed. Reg. 85343.
[5] 40 CFR § 230.10(b).
[6] 40 CFR §§ 230.10(d) and 230.12; 33 CFR §§ 332.1 and 332.3(a)(1)/40 CFR §§ 230.91 and 230.93(a)(1).

to significant degradation. The approach under consideration applies a threshold value for the percent of disturbed land cover —specifically, anthropogenic impervious surface— within a watershed in order to determine where impacts could cause or contribute to the significant degradation of aquatic resources. Using this approach, any impact that occurs within a watershed where the percent of disturbed land falls below the designated threshold is determined to not result in significant degradation, regardless of the nature or the severity of the impact itself. Furthermore, the approach also applies the designated threshold to determine when compensatory mitigation would be required. Therefore, any impact that occurs within a watershed where the percent of disturbed land falls below the designated threshold is determined to not require compensatory mitigation, regardless of the severity of the impact itself and whether or not appropriate and practicable compensation opportunities exist. Although it appears that final permit decisions for projects utilizing this specific threshold-based approach have yet to be made, the Alaska District has previously pointed to low levels of developed land cover within a project's watershed when deciding that compensatory mitigation was not required.[7] Furthermore, the development and application of this approach by project proponents appears to be based on guidance from the Alaska District itself.[8]

The use of a disturbed land cover threshold in order to determine significant degradation is based on a body of scientific literature which has evaluated the negative relationship between watershed urbanization and various indicators of aquatic resource quality based on an analysis of ambient condition.[9] Impacts to streams and wetlands from urban development result from various modifications to the land surface in the contributing watershed, such as vegetation clearing, soil compaction, ditching and draining, and covering the land with impervious surfaces. These modifications lead to subsequent changes in stormwater runoff processes including increased water volume and more rapid delivery, increased sediment volume, and increased concentrations of organic and inorganic pollutants (Booth and Jackson, 1997; Moglen and Kim, 2008). Consequently, the specific mechanisms resulting in stream and wetland degradation are numerous and complex. However, the use of surrogate measures, such as percent urbanization or

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[7] *See* Department of the Army Combined Decision Document for Permit Application No.: POA-1980-307-M5 (https://www.eenews.net/assets/2018/05/29/document_gw_04.pdf), and Department of the Army Permit Evaluation and Decision Document for Permit Application No.: POA-2015-350-M1 (https://www.eenews.net/assets/2018/05/29/document_gw_12.pdf).

[8] *See* November 10, 2016 Draft Compensatory Mitigation Plan for the Alaska Stand Alone Pipeline (http://www.asapeis.com/documents/2016-11-10_DRAFTWetlandsCompensatoryMitigationPlan.pdf), October 4, 2017 letter from Alaska Governor Bill Walker to EPA Administrator Scott Pruitt regarding the Alaska Stand Alone Pipeline which references "preliminary guidance" from the Alaska District to utilize the human disturbance threshold approach described in this whitepaper, and July 9, 2014 Alaska District internal guidance document defining the District's review procedures for compensatory mitigation decisions (https://www.eenews.net/assets/2018/05/29/document_gw_07.pdf).

[9] Although the approach is based on a body of scientific literature that has evaluated the relationship between aquatic resource degradation and watershed development (i.e., the conversion of rural land to urban land use), the approach itself has included anthropogenically disturbed land of all types (e.g., agricultural, mining, etc.) in the application of land cover thresholds.

ED_005447I_00034781-00003 Bristol Bay/Pebble Mine Permitting Process FOIAs_Final Release

impervious cover (IC), which integrate a suite of interrelated stressors, simplify these relationships and are useful for considering the cumulative impacts of watershed development (Utz *et al.*, 2009; Hilderbrand *et al.*, 2010).

Studies evaluating these relationships have reported variable results, depending primarily on the particular indicators and parameters assessed, as well as various watershed-specific and site-specific characteristics. However, general conclusions from the body of literature have been summarized by permit applicants using the threshold approach, stating that "the consensus among aquatic scientists and landscape ecologists is that statistically significant impacts to the aquatic resources and functions of a watershed occur once approximately 10% of land within a watershed is urbanized (Klein, 1979; Jones and Clark, 1987; Steedmen, 1988; Limburg and Schmidt, 1990; Weaver, 1991; Booth, 1991; MWCOG, 1992; Luchetti and Fuersteburg, 1993; Booth *et al.*, 1996; Booth and Jackson, 1997; Schueler *et al.*, 2009; Hilderbrand *et al.*, 2010)."[10] Applicants adopting the threshold approach have specifically referenced the Impervious Cover Model (ICM), first introduced in 1994 as a conceptual model to describe the negative relationship between impervious cover (IC) and various indicators of stream health and to predict the severity of stream degradation in developing watersheds (Schueler, 1994; CWP, 2003). Developed from an extensive body of research, the ICM projects that hydrological, habitat, water quality, and biotic indicators of stream health decline at around 10% IC (CWP, 2003). General predictions of the ICM conclude that streams located in watersheds with less than 10% IC, categorized as *sensitive streams*, are generally able to retain their hydrologic function and support good to excellent aquatic diversity. Conversely, streams located in watersheds with 10 to 25% IC, categorized as *impacted streams*, tend to show clear signs of declining stream health where sensitive species and some functions have already been lost from the system (Schueler, 1994; CWP, 2003).[11]

Example of How the Threshold Approach Has Been Applied

Despite the scientific merit of the research from which the proposed threshold approach is based, there are substantial concerns regarding the implementation of such an approach for the purpose of determining significant degradation. One project that has adopted the threshold approach and illustrates the concerns with the use of such an approach is the Alaska Stand Alone Pipeline (ASAP). The ASAP is a 733-mile-long, 36-inch diameter transmission mainline, designed to

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[10] *See* November 10, 2016 Draft Compensatory Mitigation Plan for the Alaska Stand Alone Pipeline, at pages 1-2, (http://www.asapeis.com/documents/2016-11-10_DRAFTWetlandsCompensatoryMitigationPlan.pdf). We note that the assertion, "…statistically significant impacts to the aquatic resources and functions of a watershed occur once approximately 10% of land within a watershed is urbanized" is not an entirely accurate representation of the cited literature. For example, Booth and Jackson (1997) make no statistical assertions, and other reports cited here (e.g., Booth, 1991) make no reference to IC thresholds at all.

[11] However, more recent work by the authors of the original ICM themselves have noted that stream degradation can occur at much lower levels of IC, and have reformulated the original ICM to reflect this variability (Schueler *et al.*, 2009).

deliver natural gas from the North Slope of Alaska to South-central Alaska. The linear project crosses 60 different HUC-10 watersheds across the state of Alaska with impacts resulting from the construction of the belowground pipeline itself, along with aboveground facilities, permanent access roads, and marine dredge and fill. Specific wetland impacts include the permanent loss of approximately 7,573 acres of wetlands, impacts to over 1,037 acres of wetlands which are underlain by permafrost, 1 acre of intertidal loss, and 171 acres of subtidal impact. Additional impacts to riverine ecosystems will result from 312 stream crossings, including 64 crossings of waters which support anadromous fishes, as well as impacts to the Yukon, Tanana, Nenana, and Susitna Rivers.

In its proposal, ASAP applied the threshold approach described above using a threshold value of 7.5% disturbed land cover within a HUC-10 watershed. The project's use of a more "conservative" value of 7.5% appears to be an attempt to account for the variability among published results, recognizing that some studies have reported "urbanization begins to have an influence on some biological parameters within watersheds at slightly lower threshold levels, ranging between 5 and 10%, depending on the parameter (May *et al.*, 1997; Hicks and Larson, 1997; Utz *et al.*, 2009; Hilderbrand *et al.*, 2010; Baker and King, 2010)."[12] The method used by ASAP to calculate this threshold value is also more conservative, including all anthropogenically disturbed land cover within a HUC-10 watershed, as opposed to only developed land cover. This maximum value of disturbed land, or d-value, was calculated as the total of existing disturbed land-cover within a watershed plus the additional area of the project's proposed wetland impacts. The 2011 National Land Cover Database (NLCD) for Alaska was utilized to determine an aggregate measure of existing disturbed land-cover. This aggregate measure was calculated by first totaling the area of land represented by the developed and planted/cultivated land cover classes, and then doubling that amount to account for the maximum possible amount of additional disturbed land, such as mining projects, which are represented by the barren land cover class but are unable to be distinguished from naturally occurring barren lands (e.g., gravel bars along braided rivers, non-vegetated mountain peaks).

Results from ASAP's analysis indicated that of the 60 HUC-10 watersheds the project traverses, three contained d-values that exceeded the 7.5% threshold. The project's impact to wetlands within these three watersheds totaled 104.97 acres (or just over 1 percent of the project's total impacted wetland area). Using this threshold to define significance under the Guidelines, ASAP posited that when project impacts occurred in watersheds with d-values greater than 7.5%, those impacts were "significant" and would require compensatory mitigation to offset those impacts. Conversely, wetland losses in watersheds where d-values were less than 7.5% were posited to be

[12] *See* November 10, 2016 Draft Compensatory Mitigation Plan for the Alaska Stand Alone Pipeline, at page 2, (http://www.asapeis.com/documents/2016-11-10_DRAFTWetlandsCompensatoryMitigationPlan.pdf). We note that Booth and Jackson (1997) report degradation effects observed at levels as low as 3%, and Schueler *et al.* (2009) note studies reporting degradation at levels as low as 2% imperviousness.

“insignificant”, and no compensatory mitigation was proposed to offset those losses. Thus, under ASAP’s conservative (i.e., *theoretically* more protective) application of the threshold approach, just over 1 percent of the project’s total impacted wetland area was determined to require compensatory mitigation.

Concerns Regarding This Approach

The scope and scale of potentially unmitigated impacts from the ASAP project highlight the concerns which have been raised regarding the use of this approach and whether such an approach is consistent with the 404(b)(1) Guidelines. When applied alone, the approach does not evaluate the comprehensive suite of direct, secondary, and cumulative impacts needed to support the factual determinations regarding significant degradation, as required by the 404(b)(1) Guidelines. The loss of aquatic resources at impact sites located in watersheds where disturbed land cover is less than the designated threshold are summarily dismissed as insignificant, regardless of the existing quality of these aquatic resources, the functions they provide on the landscape, the degree to which those functions would be impacted, or the duration of those impacts. In other words, if impacts occur in watersheds below the designated threshold the resources themselves are not characterized, and the direct, secondary, and cumulative impacts resulting from their loss or degradation are not evaluated. Therefore, sufficient information needed to determine whether impacts could cause or contribute to significant degradation and whether compensatory mitigation should be required to address potential concerns regarding significant degradation is not provided. Similarly, under this approach impacts located in watersheds where disturbed land cover is less than the designated threshold are determined to not require any compensatory mitigation regardless of whether appropriate and practicable compensation measures exist to offset some or all of the impacts.

In addition to concerns regarding compliance with the Guidelines, there are also concerns regarding the application of the scientific literature used to develop the approach and support its underlying assumptions. Specifically, concerns include the application of published thresholds that: 1) have identified levels at which complete loss has already occurred, 2) were developed in other ecoregions, which have a long legacy of human settlement, 3) are only able to reliably predict responses at the subwatershed scale, and 4) evaluate the response of aquatic resources from watershed development but not specifically from aquatic resource loss itself. Any misinterpretation or misapplication of the scientific literature is likely to result in the development of a technically flawed approach, unsuitable for the purpose of determining significant degradation, regardless of how conservative of a threshold value is designated. The discussion that follows presents a review of the literature, examining of the concerns outlined above in order to evaluate whether this body of science has been applied appropriately, and ultimately, to determine whether the approach is scientifically supported and suitable for the purpose of determining significant degradation.

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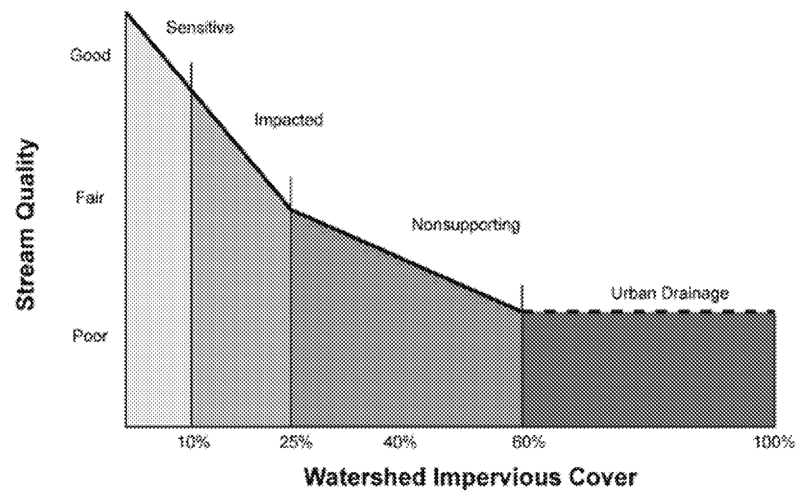
DISCUSSION

Applying Thresholds That Identify Complete Loss

The proposed approach applies a single threshold value of percent land use cover in order to determine when impacts could cause or contribute to significant degradation of aquatic resources within a watershed. The threshold approach is based on the interpretation of a body of scientific literature which has evaluated the negative relationship between urbanization and various indicators of aquatic resource quality. Although there is a broad consensus that 10% urbanization is associated with widespread degradation, published thresholds have often been developed from identifying endpoints where complete loss has already occurred. However, watershed-wide adverse influences on aquatic life support functions occur before these components are lost from the system, which are often evident at very low levels of impervious cover (e.g., < 5%) and can even begin to have an influence almost immediately (Booth and Jackson, 1997; Horner *et al.,* 1997; May *et al.,* 1997; Utz *et al.,* 2009; Schueler *et al.*, 2009; Hilderbrand *et al.,* 2010). Much of the scientific literature has identified specific upper limit thresholds associated with the response of an individual indicator. These upper limit thresholds, or extirpation thresholds (T_{95}), identify the point along a disturbance gradient where an indicator disappears from the landscape and the system loses a vital structural or functional component (Utz *et al.,* 2009; Hilderbrand *et al.,* 2010). However, lower response limits or initiation-of-impact thresholds (D_1) represent the stressor value at which a negative effect is initiated, and is often met at considerably lower levels for most taxa (Utz *et al.*, 2009; Hilderbrand *et al.*, 2010).

Although some thresholds have been identified for specific watershed functions or population level loss, it is likely that the occurrence of abrupt thresholds depends on the scale of the parameter being considered. Utz *et al.* (2009) reported that although threshold responses were evident for individual taxa, scaling up by aggregating across taxa showed linear declines in richness. Correspondingly, most studies that have identified "thresholds" associated with ecosystem level response, have acknowledged that these values don't actually represent strict thresholds *per se*, but rather the average response of a group of indicators (Booth and Jackson, 1997; Schueler, 2004; Schueler *et al.*, 2009). This is particularly important when considering sensitive species such as trout and salmon, since it is likely that the habitat requirements for many sensitive species are determined by the most sensitive stream quality indicators, rather than the average behavior of all indicators (CWP, 2003; Schueler *et al.,* 2009). Accordingly, the general consensus is that aquatic ecosystems rarely exhibit abrupt nonlinear thresholds, but rather display a continuous gradient of stream degradation as watershed development increases (Booth and Jackson, 1997; May *et al.,* 1997; Booth *et al.*, 2004; Schueler *et al.,* 2009; Utz *et al.*, 2009; Hilderbrand *et al.,* 2010). Following a meta-analysis of 35 new research studies, the ICM has actually been reformulated from its original conceptual model to reflect this understanding, with the relationship no longer being expressed as a single line, but rather a "cone" representing

(a)



(b)

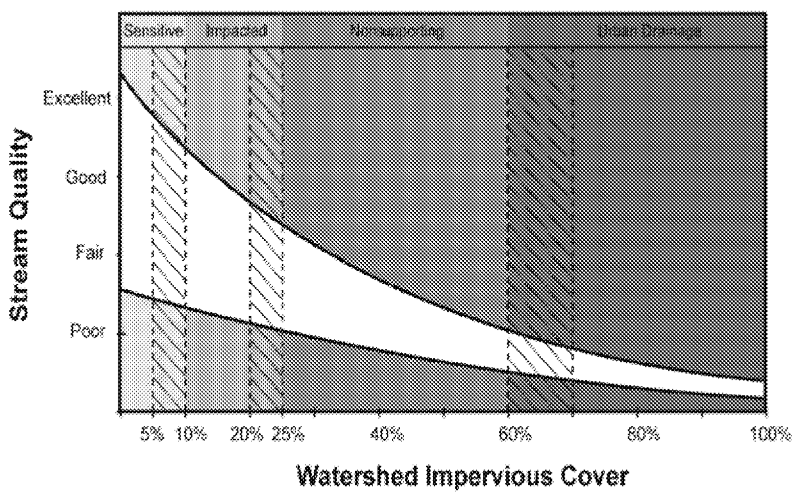


Figure 1. A comparison of two different versions of the impervious cover model (ICM). Panel (a) depicts the original ICM from its conception in 1994, whereas panel (b) depicts the reformulated version of the ICM, updated in 2009 [adapted from Schueler *et al.* 2009].

variability in the response of stream indicators (Schueler *et al.,* 2009) (Figure 1). Furthermore, because degradation is continuous and any well-defined thresholds typically identify endpoints where complete loss has already occurred, the scientific literature cautions against managing up to a threshold, as doing so could be catastrophic for biodiversity and lead to irreversible loss of aquatic-system function (Booth and Jackson, 1997; Hilderbrand *et al.*, 2010).

The proposed approach applies a single threshold based on complete loss in order to determine when impacts may cause or contribute to significant degradation. However, degradation leading to such losses is more complex. For example, degradation of waters may result in lower fertility, lower success in recruitment of juveniles, and increased predation pressures. Any of these factors could depress populations, significantly degrading waters for the aquatic life use support. Therefore, applying a threshold based on complete loss in order to determine when impacts may *cause or contribute* to significant degradation is not only arbitrary but contrary to the intent of the Guidelines.

Applying Thresholds to Pristine and Underdeveloped Ecoregions

Concerns regarding the application of a threshold based on complete loss are further compounded by the fact that these published threshold values do not necessarily apply to other physiographic regions. The evaluation of thresholds for individual species have reported substantial differences in the sensitivity of aquatic organisms to urban land use gradients among neighboring physiographic provinces (Utz *et al.,* 2009; Hilderbrand *et al.,* 2010; Utz *et al.,* 2010). Because of variations in topography, geology, and climate conditions, streams differ considerably in regards to their physicochemical response to land use conversion (Poff *et al.*, 2006; Utz *et al.*, 2010). Therefore, the response of aquatic organisms from changes in land cover may also differ significantly among regions. A meta-analysis of 35 research studies pertaining to the Impervious Cover Model (ICM) found that the percentage of IC at which stream degradation was first detected ranged from 2-15%, which depended not only on the indicator(s) used, but also on the ecoregion in which the study was conducted (Schueler *et al.,* 2009).

Additionally, it's possible that published thresholds are not applicable to particularly pristine regions. Urbanization thresholds and rates of watershed degradation have typically been developed from studies conducted within the conterminous United States, predominately from regions with a long legacy of human settlement. Impacts persisting from historic land use complicate the inferences drawn from current conditions, due to the possibility that endemic and/or sensitive taxa may have been eliminated from watersheds decades prior to urbanization (Harding *et al.,* 1998; Harding, 2003; Utz *et al.,* 2009; Utz *et al.,* 2010). This understanding may explain findings which indicate that lower IC thresholds appear to be associated with predevelopment land cover characterized by extensive forest or natural vegetation, while higher IC thresholds appear to be associated with predevelopment land cover characterized by cultivation or range management (Ourso and Frenzel, 2003; Cuffney *et al.,* 2005; Schueler *et al.,* 2009). Applying IC or urbanization thresholds to relatively pristine regions in general may be inappropriate because IC is not necessarily the most reliable metric for predicting stream degradation in sensitive subwatersheds, particularly when IC levels are low and impacts from other land use practices are present (e.g. deforestation, acid mine drainage, denudation of riparian cover) (Schueler *et al.,* 2009). The ICM has been reformulated from its original conception to account for these findings so that the relationship between IC and stream quality is no longer represented as a straight line, but rather as a cone that is widest at lower levels of IC, reflecting the variability in stream indicator scores observed when IC is less than 10% (Schueler *et al.*, 2009) (Figure 1).

This modification to the ICM suggests that IC should not be the sole metric used to predict impacts to stream biotic communities when IC is very low (Steedman, 1988; Horner and May, 1999; Booth, 2000); indeed, it is not at all clear that imperviousness is even relevant in non-urban/suburban catchments. Furthermore, given the variability in response among regions, ecological thresholds reported in the literature are not necessarily transferable. Therefore, authors of these studies caution against the direct application of published thresholds, recommending that the implementation of thresholds only be applied to urbanizing catchments and based on actual monitoring data from the specific region of interest (Schueler *et al.*, 2009; Utz *et al.,* 2009; Hilderbrand *et al.,* 2010). Thus, the published literature does not support use of these thresholds in undeveloped regions of Alaska.

Applying Thresholds at a Single HUC-10 Watershed Scale

The proposed threshold approach only considers impacts at a single broad watershed scale. Specifically, ASAP's evaluation only considered the relationship between disturbed land cover and aquatic degradation at a HUC-10 watershed scale. A HUC-10 watershed is a large watershed, covering many square kilometers (i.e., typically ranging from about 150 to 1000 km^2) and encompassing up to 5th order streams. Furthermore, the HUC-10 watersheds in Alaska, where the proposed threshold approach has been applied, are skewed past the high end of this range (ranging from 303 km^2 to 2090 km^2 for the 60 HUC-10 watersheds that the ASAP project traverses). However, most of the supporting research in identifying thresholds for percent urbanization have been conducted at the subwatershed scale (i.e., typically ranging from 5 to 50 km^2, and encompass 1st through 3rd order streams). At the subwatershed scale the influence of IC on hydrology, water quality, and biodiversity is readily apparent (Zielinski, 2001; Schueler *et al.,* 2009). Conversely, several studies that have been conducted at even slightly larger scales (i.e., 75 to 150 km^2) have failed to detect negative relationships between urbanization and stream quality indicators (Coles *et al.*, 2004; Fitzpatrick *et al.*, 2005; Sprague *et al.,* 2006). This is likely because the larger the watershed the weaker the influence of IC alone typically becomes, as the chance for confounding land use classes which may simultaneously affect stream ecosystems increases (Zielinski, 2001; King *et al.*, 2005; Utz *et al.*, 2010). The relationship between these confounding stressors and IC is further complicated since the combined effects can be additive, interactive, or one effect may diminish the other. Thus, the ability to identify IC relationships at the HUC-10 scale lies beyond the predictive power of the ICM, is unsupported by *any* of the cited literature, and application of IC relationships at this scale is not recommended (Schueler *et al.*, 2009).

Implementing a threshold at a single HUC-10 watershed scale may be inadequate because the value of developed land cover aggregated downstream has the potential to mask higher concentrations of developed land cover that occur within subwatersheds (Moglen and Kim, 2008). High levels of development to one or more subwatersheds could result in significant localized impacts, yet would not necessarily be captured by a threshold at the HUC-10. Consequently, these localized impacts captured at the subwatershed scale could in turn have a significant impact within the larger watershed. Moglen and Kim (2008) illustrate this concerning scenario by considering a larger watershed where imperviousness is below a 10% threshold and conditions are determined to be acceptable. Although, when imperviousness is examined at a smaller scale, 2 out of 6 subwatersheds exceed a 10% threshold and results in nearly 30% of the of the total stream length within the larger watershed being degraded.

When implementing a threshold approach at a single broad watershed scale, the size of the watershed directly influences the magnitude of impacts that can be permitted without requiring compensatory mitigation. Thus, the larger the watershed scale that the threshold is applied to, the greater the severity of impacts that can be summarily dismissed as insignificant. The Guidelines require that determinations regarding significant degradation consider the direct, secondary, and cumulative impacts of the proposed project. Therefore, consideration of impacts at multiple scales may be necessary to make appropriate assessments of significant degradation, and in such cases applying a threshold at a single broad scale is arbitrary.

Applying Thresholds to Evaluate Direct Impacts to Aquatic Resources

The proposed threshold approach is based on a body of science that has examined the impacts from urban development on aquatic resource quality, but not the specific effects from aquatic resource loss or conversion itself. Specifically, these studies have most commonly evaluated the relationship between urban watershed development and stream quality indicators. Studies examining the impacts to wetlands and other aquatic resources from increased urbanization and impervious cover are less common, and the ICM has not been validated for non-stream conditions (CWP, 2003; Wright *et al.*, 2006). However, urban land use is associated with wetlands of poor condition throughout the contiguous United States (USEPA, 2011); and evidence from studies that have evaluated the relationship between impervious cover and wetland degradation suggests that considerable impacts can occur before IC reaches 5% (Taylor *et al.*, 1995; Hicks and Larson, 1997; Horner *et al.,* 1997; CWP, 2003). In either case, the relationship between urban development and impairment of streams and wetlands are typically developed using single surrogate measures such as percent urbanization or impervious cover. These surrogate measures, which integrate a suite of interrelated stressors, can be useful in considering cumulative impacts to the watershed (Utz *et al.*, 2009; Hilderbrand *et al.*, 2010). However, while these surrogate measures likely incorporate direct impacts from the loss or conversion of aquatic resources to some degree, they consist primarily of indirect impacts generated by development activities of uplands. Therefore, the application of thresholds from this body of science is inadequate for determining the potential for significant degradation from direct impacts to aquatic resources. Many watersheds may not even consist of 7.5% cover (or whichever threshold value is implemented) of a specific resource type (e.g., anadromous streams). Thus, under this approach, up to 100% of a specific aquatic resource type could be lost from an otherwise unimpacted watershed, yet these impacts could be summarily dismissed as "insignificant" without further evaluation. While this scenario may seem unlikely, the possibility of its occurrence highlights a substantial concern for the use of an urban development threshold in evaluating direct impacts to aquatic resources.

Furthermore, although aquatic resource loss or conversion may be associated with urban development, measures of impervious cover or percent urbanization are not necessarily directly related to the magnitude of direct impacts within a watershed. Rather, the mechanisms and processes which result in degradation are unique; and therefore, evaluating the severity of these impacts requires separate consideration. Both wetlands and streams support a range of ecosystem functions within the greater watershed; however, the specific types of functions and the degree to which they are performed can vary greatly, depending on the type of aquatic resource and its location within the watershed network (Vannote *et al.*, 1980; Brinson, 1993). Headwater streams, for example, are disproportionately important in performing nutrient export to downstream areas, largely because the ratio of land contributing allochthonous inputs to stream surface is much higher than in downstream reaches (Vannote *et al.*, 1980). Whereas wetlands along mainstem rivers are disproportionately important for attenuating peak flows and mitigating floods downstream (Ogawa and Male, 1986; Preston and Bedford, 1988), and wetlands closer to coastal areas are more likely to be favored by nesting birds who forage in coastal waters, simply owing to proximity to the source. Therefore, the location of impacts within a watershed can significantly influence the severity of those impacts, in addition to impact size or relative proportion. For example, a discharge which creates a barrier to the passage of anadromous fish will adversely affect resources upstream of that impact. Consequently, the further down in the watershed the discharge occurs, the greater the impact; yet simultaneously, the relative percentage of developed land cover becomes smaller and smaller. The degree of impacts resulting from habitat fragmentation can also have a considerable effect in wetland systems, even under scenarios of relatively small wetland loss. Gibbs (1993) identified the risk of extinction in local populations of animals which resulted from increases in inter-wetland distance and changes to other metapopulation supporting factors when small wetlands were lost from the landscape. Therefore, although direct impacts to aquatic resources may be associated with watershed development, both the effects and the magnitude of those impacts is largely dependent upon the impact location and cannot be predicted from percent IC alone.

CONCLUSION

The primary goal of this white paper was to objectively evaluate a threshold-based approach for determining when Clean Water Act Section 404 impacts to aquatic resources may cause or contribute to significant degradation of the Nation's waters. A review of the scientific literature, from which the threshold is based, has elucidated several inadequacies resulting from the misinterpretation and misapplication of the literature. These findings lead not only to the conclusion that the approach is technically flawed and not supported by the science, but also to

ED_005447I_00034781-00012 Bristol Bay/Pebble Mine Permitting Process FOIAs_Final Release

the determination that the implementation of such an approach is not suitable for evaluating significant degradation.

Aquatic resources are variable and dynamic ecosystems; consequently, impacts leading to the degradation of aquatic resources are also variable and complex. Because the magnitude of degradation resulting from aquatic resource loss or conversion is highly dependent on the aquatic resource type, its relative abundance, and location within the watershed, determinations of significant degradation cannot be determined solely on a single arbitrary threshold at a single arbitrary scale. Recognizing this complexity, the Guidelines require that determinations of significant degradation consider the direct, secondary, and cumulative effects of permitted impacts on a case-by-case basis. Therefore, the use of this threshold-based approach for the purpose of determining significant degradation is an inappropriate oversimplification of the impact analysis required by the Guidelines. Moreover, it could also lead to violations of 40 CFR 230.10(b) or (c) because these thresholds are based on endpoints at which the literature indicates significant degradation may have already occurred.

Further, this approach is also problematic because of how it is used to inform decisions regarding when compensatory mitigation is required. As part of the approach, compensatory mitigation is not required unless impacts exceed the arbitrary threshold set for the watershed. This could lead to violations of 40 CFR 230.10(d) because when the threshold is not exceeded no compensation is required regardless of whether appropriate and practicable opportunities exist to offset some or all of the proposed impacts.

ED_005447I_00034781-00013 Bristol Bay/Pebble Mine Permitting Process FOIAs_Final Release

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